



BRIDGE CONSTRUCTION BULLETIN 180-1.0
 SECTION 180-WELDING
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Approved by	
For:	R.P.SOMMARIVA, Chief Office of Structure Construction

Subject: Field Welding of Structural Steel

There have been recent developments and problems associated with the workmanship on structural steel contracts and welding of structural steel members. This Bulletin provides an overview of the specification requirements, and provides a basic checklist of items to review before, during and after structural steel welding work. A contact list for welding support from the Materials Engineering and Testing Service (METS) is provided under Construction Bulletin, BCM 180-4.0, which is forthcoming within next month.

Work on Structural Steel members shall be governed by the requirements of the Contract Special Provisions, Standard Specifications, Section 55 *Structural Steel*, Standard Specifications Section 75, *Miscellaneous Metal*, and the most current publication of ANSI/AASHTO/AWS D1.5 *Bridge Welding Code* or ANSI/AASHTO/AWS D 1.1, *Structural Welding Code*. The procedure for the handling of Structural Steel Working Drawings is found in Bridge Construction Memo 170-3.0.

Reference copies of Bridge Welding Code, AWS D1.5-95, and Structural Steel Welding Code, AWS D1.1-94, are available. Please contact your Supervisor.

Five attachments are included with this Bulletin: Attachment No. 1 is Bridge Welding Code, AWS D1.5, OSC Contract Administration Guide; Attachment No. 2 is Structural Welding Code, AWS D1.1, OSC Contract Administration Guide; Attachment No. 3 is Safe Code of Practices for Welding Inspection; Attachment No. 4 is Checklist for Compliance with Bridge Welding Code, AWS D1.5, Attachment No. 5 includes copies of Section III *Responsibilities of Caltrans Quality Assurance Person*, and Appendix A *Field Inspection Procedure* from the METS Quality Assurance Manual.

Attachments

cc: All Jobs
ACM's
Senior BCE's
RBushey
PStolarski
BGauger

Bridge Welding Code AWS D1.5 OSC Contract Administration Guide

Knowledge

Review the requirements in the Special Provisions, the Contract Plans, and the Standard Specifications Section 55-1 .02, *Welding*.

Review the following sections of the Bridge Welding Code AWS D1.5:

- Chapter 3, *Workmanship*
- Chapter 4, *Technique*
- Chapter 5, *Qualification*
- Chapter 6, *Inspection*
- All other sections are to be reviewed as needed.

Coordination with METS

Prior to meeting with the Contractor at the start of the project, make arrangements to meet with a METS representative to discuss the contract and the welding requirements. This will help establish the roles and responsibilities regarding Caltrans quality assurance inspection.

Refer to the *METS Quality Assurance Manual* for clarification on roles and responsibilities of METS Quality Assurance (QA) personnel. (See Attachment No. 5)

Remember, the Structure Representative has the technical control over all structure work including welding. The Structure Representative is responsible to ensure that the welding is done properly. QA inspection is performed adequately, and the work is fully documented in the project files. METS personnel will provide assistance to OSC for QA inspection of welding work. However, due to limited staffing and difficulties in scheduling statewide METS inspection, OSC personnel must assist METS with QA inspection of welding.

Notice to Contractor

At the preconstruction conference, schedule a pre-welding meeting with the Contractor. Suggest that they invite to the meeting, the appropriate Sub-Contractors (Welding, Fit up & Erection, Steel Fabricator, etc.) and the Quality Control Welding Inspector(s). Prior to the meeting, provide a copy of the meeting agenda to the contractor and suggest that they bring along their quality control plan, all welders' qualification papers, testing information, and any other related welding documents.

Bridge Welding Code AWS D1.5 OSC Contract Administration Guide

Pre-Welding Meeting

Conduct the meeting with the Prime Contractor, Sub-Contractor(s), Contractor's Quality Control Welding Inspector and Materials Engineering and Testing Services (METS) representative to discuss the following:

Review specific welding requirements noted on the Contract Plans and Special Provisions.

Section 55-1.02 of the Standard Specifications requires the contractor to submit a *Quality Control Program* listing methods and personnel to satisfy the requirements of Part 6 of AWS D1.5. Review the Contractor's quality control program (plan) and discuss any deficiency.

The Contractor is responsible for Quality Control (QC) and must appoint a Quality Control Welding Inspector(s). The Contractor's QC Inspector is responsible to review all of the welds and related work performed in the field and to verify that the work is in conformance with the approved Welding Procedure Specifications (WPS) on a continuous basis. Review the qualifications, and responsibilities for the contractors proposed QC Welding Inspectors. (AWS D1.5, Part 6).

Review the requirements of the Welding Procedure Specifications (WPS), Procedure Qualification Record (PQR), Welder(s), Welding Operator and Tack Welder qualifications. (AWS D1.5, Part 5, *Qualification*). (METS should cover this portion of discussion).

Suggest the Contractor submits a welding schedule identifying all contract welding work. This will assist field inspection of welds and allow proper lead time for identifying the proper weld test to be performed. Time frames for all test results submittals and methods of reporting should be addressed.

Discuss AWS D1.5, Section 3.3 *Assembly*, to review tolerance and proper positioning of members. Incorrect fit-up will normally result in deficient welds.

Review all documents to be submitted before, during and after each portion of welding is performed. (Refer to Attachment No. 2, *Checklist for Compliance with Bridge Welding Code, AWS D1.5*)

Discuss corrective measures when welds are not in conformance with the contract documents (AWS D1.5, section 3.7).

All conversations regarding welding should be documented in writing by the Structure Representative (SR) or SR Assistant. Include a list of all attendees.

Bridge Welding Code AWS D1.5 OSC Contract Administration Guide

Field Office File

Documents related to welding work are to be filed in the contract's Project Record Files under the following categories:

Category 5: Copies of all Correspondence

Category 37: Test results for all field tests

Category 41: Certifications for electrodes

Category 42: (New Category) Contractor's submittals (copies of approved Quality Control Program, approved WPS & PQR, welders qualifications, certified welder reports, nondestructive testing (NDT) qualification, certified test reports, calibration reports for NDT equipment, QC Inspector diaries, etc.)

Category 45: Structure Rep. Diaries (including meeting notes)

Category 46: Assistant Structure Rep. and METS diaries

The use of sub-categories should be utilized to keep the welding documents together.

Inspection

The Contractor's Quality Control Inspector shall meet the inspection personnel qualifications as discussed in AWS D1.5, section 6.1.3.

The welding inspector from METS should be present on the first day of welding, unless other arrangements are made in the pre-welding meeting.

The Contractor's QC Inspector is responsible for all welding operations in the field and is required to monitor the fabrication, set up, root opening, groove angle, equipment settings, and welding papers, etc. on a regular basis. All procedures for welding, testing and documentation must be in accordance with the approved WPS. (AWS D1.5, section 6, *Inspection*).

Check the welders welding conditions and verify that the welding tolerances are meeting the contract requirements established in AWS D1.5, Section 3.

The welders, weld operators, and tack welders shall meet the qualifications and use techniques that conform to the approved WPS (consult METS for assistance).

The surface preparation shall be cleaned as necessary to produce sound welds (AWS D1.5, Section 3).

Production rates should be monitored, as needed, to ensure WPS compliance. Production rate fluctuations, especially increases, may indicate non-conformance with the Specifications.

Bridge Welding Code AWS D1.5 OSC Contract Administration Guide

Testing

Complete joint penetration groove welds in main members shall be QC tested by nondestructive testing. Personnel performing nondestructive testing shall be qualified in accordance with the American Society of Nondestructive Testing's (ASNT) Recommended Practice No. SNT-TC-1A, or equivalent (AWS D1.5, Section 6.1.3.4). METS personnel will provide assistance for all testing matters.

Radiographic Testing (RT) shall be used for examination of complete joint penetration groove welds in butt joints subject to calculated tension or reversal of stress. See Contract Plans to identify the type of stress in members. If the stresses are not identified on the Contract Plan, contact the Designer.

Ultrasonic Testing shall be used for examination of all complete joint penetration groove welds in T- and corner joints. See Contract Plans to identify the type of stress in members. If the stresses are not identified on the Contract Plan, contact the Designer.

When required, RT and UT may be used to test all complete joint penetration groove welds in butt joints in compression or shear.

Requirements of RT and UT testing are found in AWS D1.5 Section 6.7.1.2.

Weld tabs (extension bars and run off plates) shall be removed prior to testing (AWS D3.12.2).

Magnetic-particle Testing (MT) shall be used for examination of fillet welds and partial penetration groove welds joining primary components of main members (e.g. web to flange, diaphragm connection plates to web or flange, etc.). Magnetic-particle inspection of fillet welds is not required for secondary members. Consult with designer for verifications.

Requirements of magnetic-particle testing is found in AWS D1.5, section 6.7.2.

Per AWS D1.5 Section 6.5, *Inspection of Work and Records*, The Contractors QC Inspector shall keep a record of all WPS qualifications or other tests that are made. The Engineer should get copies of all certified test results and place in the field office files.

Structural Welding Code AWS D1.1 OSC Contract Administration Guide

Similar steps mentioned in Attachment No. 1 for administration of contracts with AWS D1.5 code (Knowledge, Meeting with METS, Notice to Contractor, Pre-Welding Meeting, Filing, and Inspection) should be followed for contracts with AWS D1.1, Structural Welding Code requirements.

The contract requirements for welding, welder qualification, and inspection of welding for projects with AWS D1.1 Code are similar to the projects with AWS D1.5 Code with the following exceptions:

- Currently there is no contract requirement for the Contractor to submit a *Written Quality Control Program*. Future Specifications will be revised to include requirements for a program.
- The qualifications for a qualified engineer or technician proposed by the Contractor as the QC Welding Inspector, need to be “verified” not “accepted”, by the Engineer.
- There is no mandatory nondestructive testing required by the AWS D1.1 Code. Welds can be accepted if the Quality Control Inspector and the METS welding inspector find the welding quality to be acceptable by visual inspection.
- When nondestructive testing other than visual inspection is specified in the Special Provisions, it shall be the contractor’s responsibility to ensure that all specified welds meet the quality requirements of AWS D1.1.
- If the Engineer or METS representatives has reason to believe that the welding quality does not meet the specifications, the contractor shall perform any requested testing or shall permit any testing to be performed by the State in conformance with AWS Section 6.

Code of Safe Practices Welding Inspection

- 1) All employees exposed to welding and weld inspection work must be trained in the hazards and precautions necessary to conduct the work safely.
- 2) Electrical Hazards
 - Stay clear of welding leads, particularly in wet conditions.
 - Inspect leads for frays and missing insulation, all leads must be insulated.
 - Do not touch or remove the ground lead, unless directed to do so by the welder.
 - Welding equipment should be shut off when not in use.
- 3) Fumes and gases
 - Welding operations create harmful fumes and gases; position yourself upwind and away from the welding to avoid exposure.
 - Do not enter confined spaces where welding is being done, unless properly trained and equipped as required by Caltrans Safety Manual Chapter 14.
 - Be aware that welding on galvanized or paint coated steel (particularly lead paint) produces toxic fumes and smoke, stay away from these operations unless properly trained and equipped with respiratory protection (See Caltrans Safety Manual Chapter 15).
- 4) Eye Hazards
 - Never look directly or indirectly at welding work, unless you are wearing a welding helmet or goggles with lenses properly shaded for the type of welding being done (generally a #14 shade is required for large electrodes). Be aware that reflected or indirect arc can also cause eye burns.
 - Welding operations should be isolated or shielded to prevent “flash” to adjacent workers or the traveling public.
 - Wear ANSI approved safety glasses on the job site to protect from flying particles.
- 5) Skin Protection
 - Stay clear of welding operations. Wear long sleeve shirts or coveralls to protect skin from ultraviolet rays generated from welding.
 - Be aware that metal parts may still be hot after welding is done. Wear gloves where appropriate.
- 6) Radiation
 - Weld inspection involves the use of radioactive sources, typically emitting gamma rays. These rays will penetrate clothing and skin, the best protection is to stay away. **Never touch or handle a radioactive source.** Contact the technician or inspection company immediately if you find a source out of its storage container or unattended.
 - The inspection technician must establish an exclusion zone around the work, with warning signs and tape, based on expected and measured radiation emissions. **Do not enter this area unless properly trained and equipped with a radiation detector badge.** The maximum allowable exposure is 2 millirem/hour, but exposures should be kept as low as possible.

Checklist for Compliance with AWS D1.5

Reference

If complete
()

		Contract Plans
Identify welded connections as tension, compression, shear or reversal member		Contract Plans
Identify all welds (full pen or partial pen)		Contract Plans
Identify all members as main or secondary		Contract Plans
Review special welding considerations		Special Provisions
Review working drawings		Std. Spec. 55-1.02
Review contractors written quality control program		Std. Spec. 55-1.02
Review requirements of QC inspection by the Contractor		D1.5 - 8.1.1.1
Review requirements of QA inspection by the Engineer		D1.5 - 6.1.1.2
Engineer and METS approved Welding Procedure Specification (WPS) in file.		D1.5 - 5, Part A
WPS Qualification - Gen. Requirements		D1.5 - 5.7
Procedure Qualification Record per weld configuration		D1.5 - 5
Welding Consumables (Electrodes)		D1.5 - 5.5
Electrode certification - SMAW		D1.5 - 4.6.5
Electrode certification - FCAW (s or g)		D1.5 - 4.12.3
Electrode storage (sticks only)		D1.5 - 4.5
Welder, Tack Welder, Welding Operator - General requirements and certification		D1.5 - 5.21
Welding positions		D1.5 - 5.22
Welder qualification test record		D1.5 - 5
Prequalified Standard Joint		D1.5 - Fig 2.4
Approved matching filler metals		D1.5 - Table 4.1, 4.2
Preheat and Interpass temperature		D1.5 - 4.2
Joint Fit-up tolerances		D1.5 - 3.3 Assembly
Weld profiles		D1.5 - 3.6
Backing bars or back gouging		D1.5 - 3.13
WPS for repair work (non-conformance report)		D1.5 - 3.7
Weld Termination and Cleaning of weld area		D1.5 - 3.11/3.12
Technique / Procedures for SMAW		D1.6 - 4.6
Technique / Procedures for FCAW (g or s)		D1.5 - 4.14
Inspection of work and records		D1.5 - 6.5
Obligations of the Contractor		D1.5 - 6.6
Nondestructive testing (NDT)		D1.5 - 6.7
All changes to be noted on Contract Plans (As-Built)		

**Note: Most of this information is found in the handbook provided by METS.

SECTION III

Responsibilities of Caltrans Quality Assurance Person

1. Primary Responsibility

The primary responsibility of a QA inspector is to insure that the materials and workmanship provided by the contractor meet the requirements of the applicable specifications. The QA inspector is required to verify that all specifications, codes, and special provisions requirements are met and that the contractor's QC reports are in order. The QA inspector shall make random field inspections as a means to accomplish satisfactory QA confidence. Towards the achievement of this objective, the following activities shall be performed on a regular basis:

Schedule daily/weekly meeting times with contractor's QC personnel to monitor job progress and ensure contractors QCP is in effect.

Review all QC reports, weld documentation, and NDT certifications to ensure continued compliance.

Perform random review of radiographs to insure specification compliance. METS assistance at Sacramento is available.

Perform field verification inspections. A minimum of one inspection per location or one inspection per hundred field welds will be desirable.

Document all reported and discovered non-conformance issues and contractor's proposed solutions.

Generate QA inspection reports to be turned over to the engineer in the time frame agreed upon.

To assist the QA inspectors in the performance of the above functions, a ***Field Inspection Procedure*** with the relevant forms has been included in Appendix A. The QA inspector is required to fill out these forms, as applicable, during every field inspection, and disseminate the same to the engineer and all other impacted personnel.

2. Specification Issues.

2.1 It is not the function of the contractor nor the QA personnel to decide issues of materials or design. These issues have been previously decided by the specification, the design requirements, the referenced codes, or will be addressed by the engineering staff as needed. Should a specification problem be brought to your attention, notify the engineer in writing as agreed.

Office of Materials Engineering and Testing (METS)
Quality Assurance Manual for Field Welding/Non Destructive Testing

2.2 The contractor must build the product as specified. The QA inspector insures that the product is built as specified by reviewing procedures, qualifications, technique, and documentation. An amount of field verification as determined by the METS Section Chief and the engineer is necessary. Any deviation from the requirements of the specification must be thoroughly investigated and approved in writing by the engineer, prior to implementation.

APPENDIX A

Field Inspection Procedure

For each inspection there will be a check list to assist the inspector in covering all the areas necessary to achieve a complete Quality Assurance program. The following is a list of forms.

- 1.) Spec. Review: This form will be used to make the Caltrans Engineer and the METS Inspector aware of all required specifications and Testing
A review of the contractors Quality Control and welding paper work.
- 2.) Prejob: This is a record of the meeting with the Prime contractor, Quality control, the Welding contractor, and Testing company.
A review of the contractors responsibility for Quality Control
A review of the Quality Control Inspectors duties and responsibilities.
A review of Nondestructive testing requirements and the necessary documentation.
- 3.) Daily Report: This a record of the METS Inspectors Quality assurance on the Job.
A review of the Quality control inspection reports.
A record of any interaction with Caltrans Personnel
A record of any interaction with the Contractors personnel
A record of any verification inspection and nonconformance.
- 4.) Nonconformance: This is a record of Unacceptable work.
Type of problem (Welding, Fitting, Procedural, etc.)
List of locations
How was the unacceptable work discovered.
Who was notified and when.
What is proposed to rectify the problem.
Each type of nonconformance shall be listed on a separate form.
- 5.) Notification: This form is documentation and notification to the Caltrans Engineer from the METS inspector that the work does not meet the Specification.
This form will be used when the contractors Q.C. has accepted or overlooked unacceptable work.
A request that the work in question be reinspected.
A request for a written explanation from the Q.C. inspector.

Quality Assurance for field welding

Caltrans Quality Control and specification review

Special Provisions

List all references to welding (Section and Paragraph) and brief description
 Highlight all references to other Specifications

1. _____
2. _____
3. _____
4. _____
5. _____

Standard Specifications

List all references to welding (Section and Paragraph) and brief description
 Highlight all references to other Specifications

1. _____
2. _____
3. _____
4. _____

AWS (Welding and Nondestructive Testing)

Code: **D-1.5 (Bridges)** _____ **D-1.4 (Reinforcing)** _____ **D-1.1 (Structural)** _____

- 1.) **Obligations of the Contractor** (Section _____ Paragraph _____)
- 2.) **Inspection Personnel Qualifications** (Section _____ Paragraph _____)
 Qualifications of Welding Inspector. (Review documentation)
- 3.) **Nondestructive Testing** (Section _____ Paragraph _____)
 Type of test required: RT _____ UT _____ MT _____
 Extent of Testing (Section Paragraph _____)
- 4.) **Welding Procedure Specifications** (Section _____ Paragraph _____)
 (PQR) Procedure Qualification Record _____
 (WPS) Welding Procedure Specifications _____

5.) **Welder Qualification** (Section _____ Paragraph _____)

Name	Tests Required	Positions
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Quality Assurance for Field Welding

Welding and Inspection Q. C. / Q. A. Meeting

This meeting shall take place prior to the start of the job to assure the contractor will be in conformance with the specifications. A representative from the Prime contractor, the approved welding inspector, the Welding contractor, the personnel performing nondestructive testing, the Caltrans Engineer, and the METS inspector should be present.

All parties involved in inspection or testing shall have copies of all required specification. This should be verified by asking each individual attending the meeting if they have (Special Provisions, Standard Specification, and AWS)

Prime Contractors Representative YES _____ NO _____
 The Welding Inspector Q. C. YES _____ NO _____
 The NDT Inspector YES _____ NO _____

The role of the **Prime Contractor** in assuring quality work is:

1. The contractor shall be responsible for visual inspection and nondestructive testing.
 The contractor is responsible for necessary correction of all deficiencies in materials and workmanship (1.____ Section _____ Paragraph_____)
2. The contractor shall hire qualified and competent personnel to perform inspection and testing
3. The contractor shall schedule nondestructive testing to facilitate attendance by the QA Inspector when requested by the Engineer.

The role of the **Quality Control Inspector** is:

1. Review welding procedures and welder qualification to assure conformance to the specification.
2. Perform inspection prior to assembly, during assembly, during welding and after welding as specified in AWS and additionally as necessary to assure that materials and workmanship conform to the requirements of the contract.
3. The Inspector shall record the locations of inspected areas and the findings of all nondestructive tests, together with detailed descriptions of all repairs made.

The role of the **NDT Technician** is:

1. The Inspector shall identify with a distinguishing mark or adequate document control as approved by the Engineer all parts or joints that the technician tested and approved.
2. The technician shall perform nondestructive Testing in accordance with all applicable Specifications.
3. The technician shall approve satisfactory welds, or reject unsatisfactory welds and report the results to the contractor in writing the same day.

All parties attending meeting :

Print Name	Signature	Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

METS INSPECTOR FIELD REPORT

Contract # _____ Date _____
Job Name _____ Report # _____
Company Name, Address _____ CWI name _____
Arrival Time _____ Departure Time _____ CWI there? _____

Inspected CWI reports _____

Checked rod ovens _____, Electrodes to specification _____, Weld procedures _____, Welder Qual _____

Joint fitup _____, Mill reports _____,

Item Inspected _____ Location _____

Summary of discussions with Contractor/Caltrans personnel

Discrepancies noted

Corrections to be made by

Reported to RE

Signature

Quality Assurance for field Welding

Nonconformance Report

Contract Number _____ Date _____

Type of Problem: Welding _____ Fitt-up _____ Procedural _____ Other _____

Description _____

Location _____

Who found the problem ? _____

Who was notified and when ? _____

Was the Caltrans Engineer notified ? _____

Name of the Quality Control Inspector _____

Was the Quality control Inspector aware of the problem ? _____

What is the Contractor proposing to correct the problem ? _____

What is METS recommendation _____

Print METS Inspectors Name _____

Title _____

Quality Assurance for Field Welding

Notification of Nonconformance

Contact Number. _____ **Date** _____

Description of nonconformance: _____

Specification reference. Spec. _____ Section _____ Paragraph _____

Draw detail below:

Include dimensions, label areas, and highlight the problem areas with circles or arrows.

The METS Inspector shall notify the Caltrans Engineer of nonconformance as soon as possible. This report is for Caltrans Personnel only and used to help the Engineer assess the problem and the effectiveness of the contractors Quality Control. If it is determined that the Quality Control is not sufficient to assure that the materials and workmanship conform to the requirements of the Specification the Engineer shall request an explanation in writing from the Prime contractor. When unacceptable work is found by the Quality Assurance Inspector (METS) this should be considered evidence that the Quality Control is not sufficient. If it is determined that the Q.C. Inspector is not qualified based on the fact that he does not recognize unacceptable work the Engineer shall have the individual responsible removed and replaced.

METS Inspector _____